**Claims**

1. A radar pulse compression system having an encoder and a decoder, said encoder including a plurality of optical delay lines and switches responsive to a phase control code for selecting a particular sequence of delays, said decoder counteracting the delays imposed by the encoder by applying counteracting delays to a received signal, the decoder including an optical tapped delay line having a plurality of taps and further including a plurality of additional optical delays lines coupled to said taps, the plurality of additional optical delay lines imposing said counteracting delays which counteract the delays imposed by the encoder.

2. The radar pulse compression system of claim 1 wherein the phase control code is a multi-bit, m-state code that defines a pattern having m possible delay states for each bit.

3. The radar pulse compression system of claim 2 wherein the phase control code is a multi-bit two state code that defines a binary sequence of delays.

4. The radar pulse compression system of claim 1 wherein the encoder applies delay to a wideband or multiple frequency RF waveform.

5. The radar pulse compression system of claim 4 wherein the decoder applies the counteracting delays to the received signal to thereby decode the received signal.

6. The radar pulse compression system of claim 1 wherein the phase control code corresponds to a sequence of delays which can be organized into delay subsets in which the delays of each subset follow an identical sequence and wherein a delay set comprising all of the delay subsets corresponds to a further sequence of delays which are applied subset by subset.

7. The radar pulse compression system of claim 6 wherein the decoder includes a lightwave

preprocessor and an electronic processor, wherein the lightwave preprocessor is effective to decode received signals according to said identical sequence at a delay subset level of decoding and wherein the electronic processor is effective to decode received signals according to said further sequence of delays at a delay set level of decoding.

8. The radar pulse compression system of claim 1 wherein the input signal comprises a plurality of frequency components, each frequency component having a different phase shift imposed by the encoder.

9. The radar pulse compression system of claim 7 wherein the further sequence of delays follows a sequence having a bit length N and wherein, after each N delays at the delay set level said identical sequence is modified.

10. The radar pulse compression system of claim 8 wherein the optical tapped delay line has delay elements between successive taps thereof, the delays between successive taps corresponding to said N delays.

11. The radar pulse compression system of claim 1 wherein loss/gain elements are associated with the taps of the optical tapped delay line for adjusting the range sensitivity of said radar pulse compression system.

12. The radar pulse compression system of claim 1 wherein the plurality of switches is reconfigured at each phase code interval to select a temporal sequence of delay paths.

13. The radar pulse compression system of claim 1 wherein the encoder receives a RF signal and includes at least one set of phase-selector switches and at least two optical delay paths, said switches determining which of said at least two optical delay paths carry the RF signal to an output of said encoder

14. The radar pulse compression system of claim 1 wherein the encoder includes a plurality of optical tapped delay lines each having a plurality of taps, the additional optical delay lines being coupled at outputs thereof from each tap for imposing a phase delay to the signal at each tap in accordance with the phase control code, the additional optical delay lines having outputs which are summed together at one or more summing junctions, the summing junctions being functionally coupled to still further additional delay lines having outputs that are summed together as still further one or more junctions, the combination of additional optical delay lines and still further additional optical delay lines imposing counteracting delays for a multilayer phase control code.

15. The radar pulse compression system of claim 1 wherein plurality of optical delay lines are provided by a plurality of optical fibers or a plurality of optical waveguides.

16. The radar pulse compression system of claim 1 wherein the decoder includes an optical modulator for modulating a lightwave carrier with the received signal, a lightwave phase decoder for phase decoding an output of the optical modulator, and a photodetector for converting the output of the lightwave phase decoder to radio frequency as a decoded receiver waveform.

17. The radar pulse compression system of claim 16 wherein the lightwave carrier has multiple wavelengths.

18. The radar pulse compression system of claim 17 wherein the lightwave phase decoder includes said optical tapped delay line having said plurality of taps, and wherein said additional optical delay lines having outputs that are summed together to produce a summed optical output, said summed optical output being coupled to said photodetector for converting the output of the lightwave phase decoder to radio frequency as a decoded receiver waveform.

19. The radar pulse compression system of claim 18 wherein said plurality of taps comprises a plurality of wavelength dropping filters, each wavelength dropping filter selecting light modulated onto a different wavelength selected from said multiple wavelengths of the lightwave carrier.

20. The radar pulse compression system of claim 18 wherein said summed optical output is produced by a multi-wavelength combiner coupled to said additional optical delay lines.

21. The radar pulse compression system of claim 1 wherein the encoder and decoder are each disposed on a monolithic substrate.

22. The radar pulse compression system of claim 1 wherein the encoder and decoder are both disposed on a common monolithic substrate.

23. The radar pulse compression system of claim 22 wherein said plurality of optical delay lines, said optical tapped delay line and said plurality of additional optical delay lines are provided by optical waveguide structures fabricated on said common monolithic substrate.

24. A phase decoder for a radar receiver comprising:

(a) an optical modulator for modulating a lightwave carrier with a radio frequency radar return waveform from the receiver;

(b) a lightwave phase decoder for phase decoding the output of the optical modulator, the phase decoder including phase selector switches for switching in and out delay lines of different delays in response to a phase select control code; and

(c) a photodetector for converting the output of the lightwave phase decoder to radio frequency as a decoded receiver waveform.

25. The phase decoder for a radar receiver of claim 24 wherein the phase control code is a multi-bit, m-state code that defines a pattern having m possible delay states for each bit.

26. The phase decoder for a radar receiver of claim 24 wherein the phase control code is a multi-bit two state code that defines a binary sequence of delays.

27. The phase decoder for a radar receiver of claim 24 wherein the lightwave decoder includes an optical tapped delay line having a plurality of taps, the phase selector switches being coupled at outputs thereof from each tap for imposing a phase delay to the signal at each tap in accordance with the phase control code, the phase selector switches having outputs which are summed together.

28. The phase decoder for a radar receiver of claim 24 wherein the lightwave decoder functionally includes a plurality of tapped delay lines each having a plurality of taps, the phase selector switches being coupled at outputs thereof from each tap for imposing a phase delay to the signal at each tap in accordance with the phase control code, the phase selector switches having outputs which are summed together at summing junctions, the summing junctions being functionally coupled to still further phase selector switches which are coupled at outputs thereof to each summing junction for imposing a phase delay to the signal at each summing junction in accordance with the phase control code, the still further phase selector switches having outputs which are functionally summed together at another summing node.

29. A method of generating and processing RF radar transmit and return waveforms comprising:

(a) modulating RF radar transmit and return waveforms onto lightwave carriers;

(b) photonically encoding the lightwave carrier associated with the radar transmit waveform and photonically decoding the lightwave carrier associated with the radar return waveform using a decoding preprocessor to partially decode the radar return signal; and

(c) photodetecting the encoded lightwave carrier associated with the radar transmit waveform and the lightwave carrier associated with the radar return waveform.

30. The method of claim 29 further including applying electronic pulse compression techniques to the photodetected lightwave carrier associated with the radar return waveform.

31. The method of claim 30 wherein the encoding step includes switching in and out optical delay-lines to produce desired RF phase shifts in the waveform to be transmitted.

32. The method of claim 31 wherein the decoding step includes obtaining appropriately delayed copies of the return waveform to be decompressed and applying RF phase shifts to those copies, the RF phase shifts applied to said copies having associated phase shifts from the encoding step, the total delay for each associated encoding and decoding phase shift being a fixed total delay.

33. The method of claim 30 wherein the decoding preprocessor creates clock and data waveforms that are supplied to an electronic processor, said electronic processor applying electronic pulse compression techniques to the photodetected lightwave carrier associated with the radar return waveform.

34. The method of claim 33 wherein a multi-layer phase code is used to photonically encode said lightwave carrier associated with the radar transmit waveform.

35. The method of claim 34 wherein said multi-layer phase code has a first layer and at least one additional layer, said decoding preprocessor decoding said first layer and said electronic processor decoding said at least one additional layer of said multi-layer phase code.